Schedule of Capsule Talks
August 25, 2008

Session I (3088 East Hall)
Chair: Andreas Blass

9:00 am: Christopher Hall, Big Galois groups modulo ℓ

9:30 am: Elizabeth Wulcan, Residue currents

10:00 am: Matthew Simpson, Contractions of the moduli space of curves

10:30 am: Wenliang Zhang, Local cohomology

11:00 am: Michael Khoury, What is the Langlands program?

11:30 am: Francois Dorais, Countable and uncountable perfect graphs

Session II (4096 East Hall)
Chair: Ralf Spatzier

9:00 am: Enrique Torres-Giese, Varieties of representations and group cohomology

9:30 am: Alexandra Pettet, TBA(Geometric Group Theory)

10:00 am: Yvonne Lai, An effective compactness theorem for Coxeter groups

10:30 am: Lars Louder, Krull dimension for limit groups

11:00 am: Christopher Mooney, On boundaries of CAT(0) groups

11:30 am: William Breslin, Geometry of surfaces in hyperbolic 3-manifolds

Session III(4088 East Hall)
Chair: Curtis Huntington

9:30 am: Chunjing Xie, Multidimensional steady compressible flows through nozzles

10:00 am: Paul Kessenich, Global existence for the damped 3D wave equation

10:30 am: Fernando Carreon, Singular limits of reaction diffusion equations of KPP-Fisher type in an infinite cylinder

11:00 am: Song Yao, Risk measures and nonlinear expectations

11:30 am: Weihua Geng, Interface method and Green's function based Poisson Boltzmann equation solver and interface technique based molecular dynamics

Abstracts:

William Breslin, Geometry of surfaces in hyperbolic 3-manifolds

There exists a fixed positive constant C such that an incompressible surface or a strongly irreducible Heegaard surface in a complete orientable hyperbolic 3-manifold is isotopic to a surface whose principal curvatures are bounded in absolute value by C. I will talk about what these surfaces are and why some people are interested in them.

Fernando Carreon, Singular limits of reaction diffusion equations of KPP-Fisher type in an infinite cylinder

In this talk, the limiting long time behavior of scalar reaction diffusion equation with slowly changing coefficients is discussed. This equation has been studied in phenomena appearing in biology and combustion theory. The asymptotic behavior of the solutions to this equation are obtained using the notion of viscosity solutions of parabolic equations and techniques from homogenization theory of PDE's. The limiting behavior is characterized using the viscosity solution of a first order PDE.

Francois Dorais, Countable and uncountable perfect graphs

The finite version of Ramsey's Theorem (for pairs) states that any graph with n vertices contains a clique or an anticlique of size about $\log n$. For perfect graphs, $\log n$ can be improved to $\sqrt{n}$. In view of this, it is natural to expect that infinite perfect graphs also have "better" Ramsey properties than typical infinite graphs. Of course, it is necessary to redefine what "better" means in the infinite case.

For the countable case, I will present some recent results and conjectures in Reverse Mathematics that support the thesis that perfect is better. For the uncountable case, the situation is not as clear. I will present some old and recent results in Set Theory that suggest that uncountable perfect graphs do not have better Ramsey properties, but that these Ramsey properties fail for better reasons.

Weihua Geng, Interface method and Green's function based Poisson Boltzmann equation solver and interface technique based molecular dynamics

A novel method is presented for solving the Poisson-Boltzmann (PB) equation based on a rigorous treatment of geometric singularities of the dielectric interface and a Green's function formulation of charge singularities. In the present Green's function formalism, charge singularities are transformed into interface jump conditions, which are treated on an equal footing as the geometric singularities in our Matched Interface and Boundary (MIB) method framework. The resulting method, denoted as MIBPB-III, is able to provide highly accurate electrostatic potentials at a mesh as coarse as 1.2 angstrom for proteins.

After obtaining efficient and accurate PB solver, PB based molecular dynamics (MD), which has a potential to tackle large biological systems, can be futher developed. The present work applies the interface method to the development of the first PB based MD method that directly admits sharp molecular surfaces. Extensive numerical tests are carried out to validate the accuracy and stability of the present electrostatic force calculation.

Christopher Hall, Big Galois groups modulo ℓ

Many questions in arithmetic geometry give rise to families of Galois (field) extensions parametrized by a rational prime ℓ. In most cases it suffices to explicitly determine the Galois groups for all sufficiently large ℓ, though this is a hard problem in general. In some cases auxiliary symmetry considerations allow one to bound the group from above, and then one would also like to determine whether or not the groups are almost always as big as possible. We will discuss some well known examples and, if time permits, briefly point out how solutions to these problems bring together techniques and results from group theory, arithmetic geometry, and number theory.

Paul Kessenich, Global existence for the damped 3D wave equation

I will discuss methods for proving long time existence results for parabolic perturbations of the quasilinear 3D wave equation. I will present the difficulties posed by the problem and highlight the tools used to overcome these obstacles including local energy decay estimates and generalized Sobolev inequalities.

Michael Khoury, What is the Langlands program?

The purpose of this short talk is to give a brief overview of the Langlands Program, focusing on the goals of the program and on the diverse subject areas that it involves. We begin by defining automorphic forms, automorphic representations, and L-functions. We then give a sketch of the Langlands Conjecture and the notion of Langlands functoriality.

Yvonne Lai, An effective compactness theorem for Coxeter groups

Through highly non-constructive methods, works by Bestvina, Culler, Feighn, Morgan, Paulin, Rips, Shalen, and Thurston show that if a finitely presented group does not split over a small subgroup, then the space of its discrete and faithful actions on $\mathbf{H}^n$, modulo conjugation, is compact for all dimensions. Although this implies that the space of hyperbolic structures of such groups has finite diameter, the known methods do not give an explicit bound. We establish such a bound for Coxeter groups. We find that either the group splits over a small subgroup or there is a constant C and a point in $\mathbf{H}^n$ that is moved no more than C by any generator. The constant C depends only on the number of generators of the group, and is independent of the relators.

Lars Louder, Krull dimension for limit groups

Many basic notions from algebraic geometry have analogs in algebraic geometry over groups. In particular, algebraic sets defined over a torsion free

hyperbolic group Γ have unique decompositions into irreducible components. This, in turn, leads to a description of an irreducible variety as the set of homomorphisms from a "limit group" to Γ. Once this notion is in place one can ask whether or not varieties have finite Krull dimension. I will very briefly describe some ingredients required in the solution to this problem when Γ is free, and indicate some difficulties which arise in the more general case.

Christopher Mooney, On boundaries of CAT(0) groups

The CAT(0) condition is a geometric notion of nonpositive curvature similar to Gromov's definition of hyperbolicity. If a group G acts properly discontinuously and cocompactly on a CAT(0) space X then we call G a CAT(0) group. In this setup the visual boundary of X is called a boundary of G. In contrast to the hyperbolic setting, the boundary of a CAT(0) group need not be well-defined up to homeomorphism. In this talk we present some results concerning boundaries of CAT(0) groups as well as motivating open questions.

Matthew Simpson, Contractions of the moduli space of curves

One of the central concepts in birational geometry is the study of contractions (roughly speaking morphisms with connected fibres). Ideally, understanding contractions give us a way to study the original variety (and maps from that variety) in terms of other varieties which are in some ways simpler. In the case where the variety is the moduli space of curves, this is especially interesting because contractions often turn out to be a related moduli space. In this talk I will discuss some known results and various open problems relating to contractions of the moduli space of curves.

Enrique Torres-Giese, Varieties of representations and group cohomology

In this talk I will describe the construction of a natural filtration of the classifying space of a group defined by means of the lower central series of free groups and varieties of representations. I will discuss some of their main properties as well as some (potential) applications. This is joint work with A. Adem and F. Cohen.

Elizabeth Wulcan, Residue currents

I will discuss how analytic varieties or more generally ideals of holomorphic functions can be naturally represented by analytic objects - so-called residue currents. This has been used, for example, to obtain effective results in commutative algebra.

Chunjing Xie, Multidimensional steady compressible flows through nozzles

In this talk, first, I will discuss our recent work on steady compressbile Euler flows through nozzles, where we will focus on subsonic and subsonic-sonic flows. Then, I will talk about our current and possible future research on steady Euler-Poisson equations which arise from semi-conductors and plasmas.

Song Yao, Risk measures and nonlinear expectations

Risk measures have been widely used to quantify the downside risk exposed to a portfolio of financial assets. Recent research has shown that any coherent risk measure under certain domination condition can be represented by a nonlinear expectation, which is generated by backward stochastic differential equations (BSDE for short). First introduced as adjoint processes in the maximum principle for stochastic control problems, the theory of BSDEs has grown rapidly, and its applications have been found in various areas, such as mathematical finance, stochastic optimal control and stochastic differential games. One of my research concerns is to extend the representation result to the case of quadratic BSDEs (the BSDEs with quadratic-growth generator) so that a more general class of risk measures can be represented.

Wenliang Zhang, Local cohomology

After a brief introduction to local cohomology, I will concentrate on two of the main themes in this research area: vanishing and finiteness. Some of the main results and open questions will be reviewed.